



Chapter Three

FACILITY REQUIREMENTS

FACILITY REQUIREMENTS



To properly plan for the future of Ryan Airfield, it is necessary to translate forecast aviation activity into the specific types and quantities of facilities that can adequately serve this identified demand. This chapter uses the results of the forecasts conducted in Chapter Two, as well as established planning criteria, to determine the airfield (i.e., runways, taxiways, navigational aids, marking and lighting), and landside (i.e., hangars, terminal building, cargo buildings, aircraft parking apron) facility requirements.

The objective of this effort is to identify, in general terms, the adequacy of the existing airport facilities, outline what new facilities may be needed, and when these may be needed to accommodate

forecast demands. Having established these facility requirements, alternatives for providing facilities will be evaluated in Chapter Four to determine the most cost-effective and efficient means for implementation.

Recognizing that the need to develop facilities is determined by demand, rather than a point in time, the requirements for new facilities have been expressed for the short, intermediate, and long term planning horizons, which roughly correlate to five-year, ten-year, and twenty-year time frames. Future facility needs will be related to these activity levels rather than a specific year. **Table 3A** summarizes the activity levels that define the planning horizons used in the remainder of this master plan.

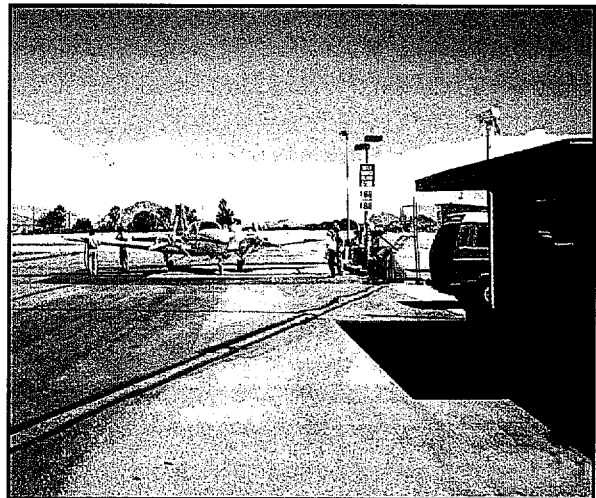


TABLE 3A
Planning Horizon Activity Levels

	Short Term Planning Horizon	Intermediate Term Planning Horizon	Long Term Planning Horizon
Based Aircraft	265	292	353
Annual Operations	184,000	208,000	261,000

AIRFIELD REQUIREMENTS

Airfield requirements include the need for those facilities related to the arrival and departure of aircraft. These facilities are comprised of the following items:

- Runways
- Taxiways
- Navigational Aids
- Airfield Marking and Lighting

The following airfield facilities are outlined to describe the scope of facilities that would be necessary to accommodate the airport's role throughout the planning period.

AIRFIELD DESIGN CHARACTERISTICS

The selection of appropriate FAA design standards for the development and location of airport facilities is based primarily upon the characteristics of the aircraft which are currently using, or are expected to use the airport. The critical design aircraft is defined as the most demanding category of aircraft which conducts 500 or more operations per year. Planning for future aircraft use is of particular importance since design standards are used to plan

separation distances between facilities. These standards must be determined now since the relocation of these facilities could be for more expensive at a later date.

The FAA has established a coding system to relate airport design criteria to the operational and physical characteristics of aircraft expected to use the airport. This code, the airport reference code (ARC), has two components: the first component, depicted by a letter, is the aircraft approach category and relates to aircraft approach speed (operational characteristic); the second component, depicted by a Roman numeral, is the airplane design group and relates to aircraft wingspan (physical characteristic). Generally, aircraft approach speed applies to runways and runway-related facilities, while airplane wingspan primarily relates to separation criteria involving taxiways, taxilanes, and landside facilities.

According to FAA Advisory Circular (AC) 150/5300-13, **Airport Design**, an aircraft's approach category is based upon 1.3 times its stall speed in landing configuration at that aircraft's maximum certificated weight. The five approach categories used in airport planning are as follows:

Category A: Speed less than 91 knots.

Category B: Speed 91 knots or more, but less than 121 knots.

Category C: Speed 121 knots or more, but less than 141 knots.

Category D: Speed 141 knots or more, but less than 166 knots.

Category E: Speed greater than 166 knots.

The airplane design group (ADG) is based upon the aircraft's wingspan. The six ADG's used in airport planning are as follows:

Group I: Up to but not including 49 feet.

Group II: 49 feet up to but not including 79 feet.

Group III: 79 feet up to but not including 118 feet.

Group IV: 118 feet up to but not including 171 feet.

Group V: 171 feet up to but not including 214 feet.

Group VI: 214 feet or greater.

Exhibit 3A summarizes representative aircraft by ARC.

In order to establish several airfield design requirements, an ARC should first be determined, then appropriate airport design criteria can be applied. This begins with a review of the type of

aircraft using and expected to use Ryan Airfield.

FAA advises designing all elements to meet the requirements of the airport's most demanding, or critical aircraft. As discussed earlier, this is the aircraft, or group of aircraft conducting 500 or more operations per year.

Ryan Airfield currently accommodates a wide variety of general aviation and some military aircraft use. The large majority of aircraft using the airport are small single and multi-engine aircraft (which fall within approach categories A and B and airplane design group I). The airport is also used less frequently by business turboprop, and business jet aircraft (which fall within approach categories B, C, and D and airplane design groups I and II). The airport is also the base for ARDCO, a U.S. Forest Service contractor, who uses C-54 aircraft for aerial firefighting. These aircraft fall within approach category B and airplane design group III.

At the present time, business jet use does not meet the 500 annual operation criteria to qualify as the critical aircraft. Therefore, the C-54 is the existing critical aircraft at Ryan Airfield, making the existing ARC B-III.

In the future, small single and twin-engine aircraft will continue to comprise the majority of the operations at Ryan Airfield, however, business jet activity can be expected to increase above 500 annual operations. Thus, a business jet will become the critical aircraft by the intermediate planning horizon. Over the long term, this could include a full

range of corporate business aircraft such as the Gulfstream IV (ARC C-II) and the Lear 35 (ARC D-I).

Runway design standards include runway width, object free area, safety area, runway-taxiway separation, etc. The most critical ARC for this element at Ryan Airfield in the future will be D-II. For taxiway and ground circulation, the design group is most critical. Therefore the critical ARC for taxiway design standards will continue to be B-III.

AIRFIELD CAPACITY

Analysis of airfield capacity and delay was examined for this master plan utilizing FAA Advisory Circular (AC) 150/5060-5, **Airport Capacity and Delay**. The methodology presented in this advisory circular and utilized here defines airfield capacity in the following major terms:

Hourly Capacity of Runways: The maximum number of aircraft operations that can take place in one hour.

Weighted Hourly Capacity: Average of hourly capacities for various runway use scenarios weighted according to percentage of use.

Annual Service Volume: A reasonable estimate of an airport's capacity, taking into account runway use, aircraft mix, weather conditions, etc., that would be encountered over a year's time.

Annual Aircraft Delay: Total delay incurred by all aircraft on the airfield in one year.

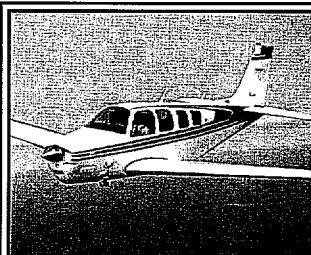
As indicated on **Exhibit 3B**, the capacity of an airport is affected by several factors including airfield layout, meteorological conditions, runway use, aircraft mix, percent arrivals, percent touch-and-go's, and exit taxiway locations. These factors are described in the following paragraphs.

Airfield Layout

The layout of the runways and taxiways directly affects an airfield's capacity. This not only includes the location and orientation of the runways, but the percent of time that a particular runway or combination of runways is in use and the length, width, weight bearing capacity, and instrument approach capability of each runway at the airport. The length, width, weight bearing capacity, and instrument approaches available to a runway determine which type of aircraft may operate on the runway and if operations can occur during poor weather conditions.

• Runway Configuration

The existing runway configuration consists of two parallel runways (6R-24L and 6L-24R) and a crosswind runway (15-33). Runway 6R has the only instrument approach available to airport. Since a single runway is



A-I

Beech Baron 55
Beech Bonanza
 Cessna 150
 Cessna 172
 Piper Archer
 Piper Seneca



C-I, D-I

Lear 25, 35, 55
 Israeli Westwind
 HS 125



B-I

less than 12,500 lbs.

Beech Baron 58
 Beech King Air 100
 Cessna 402
Cessna 421
 Piper Navajo
 Piper Cheyenne
 Swearingen Metroliner
 Cessna Citation I



C-II, D-II

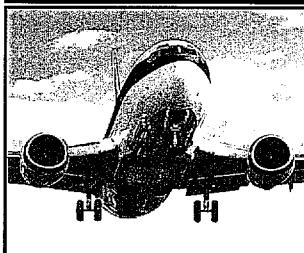
Gulfstream II, III, IV
 Canadair 600
 Canadair Regional Jet
 Lockheed JetStar
 Super King Air 350



B-II

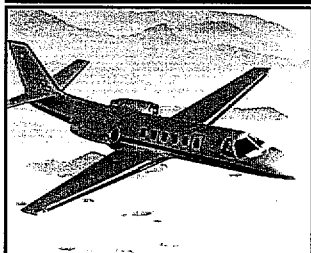
less than 12,500 lbs.

Super King Air 200
 Cessna 441
 DHC Twin Otter



C-III, D-III

B 727-200
 B 737-200
B 737-300, 400, 500
 DC-9
 Fokker 70, 100
 MD-80
 A320



B-I, II

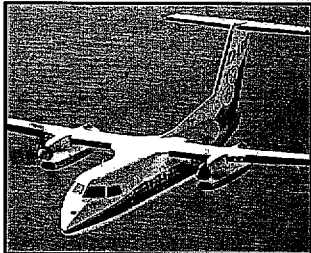
over 12,500 lbs.

Super King Air 300
 Beech 1900
 Jetstream 31
 Falcon 10, 20, 50
 Falcon 200, 900
Citation II, III, IV, V
 Saab 340
 Embraer 120



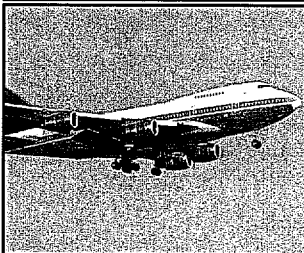
C-IV, D-IV

B-757
B-767
 DC-8-70
 DC-10
 MD-11
 L1011



A-III, B-III

DHC Dash 7
DHC Dash 8
 DC-3
 Convair 580
 Fairchild F-27
 ATR 72
 ATP



D-V

B-747 Series
 B-777

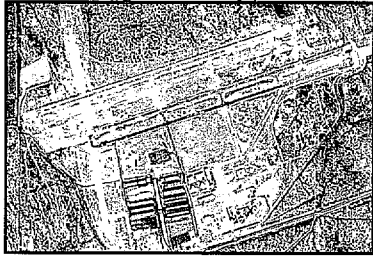


Exhibit 3A

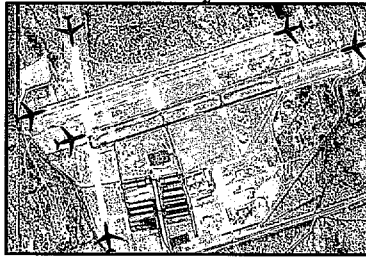
AIRPORT REFERENCE CODES

AIRFIELD LAYOUT

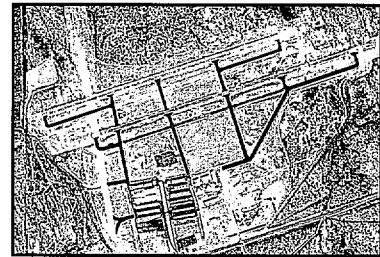
Runway Configuration



Runway Use

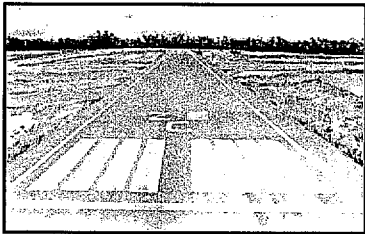


Number of Exits

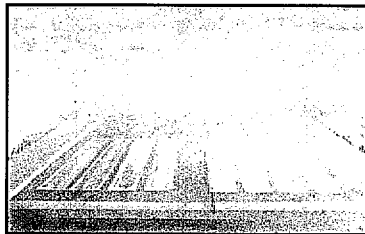


WEATHER CONDITIONS

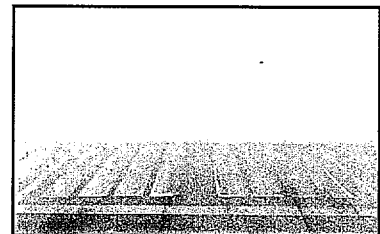
VFR



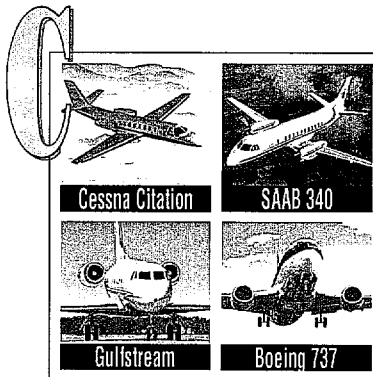
IFR



PVC

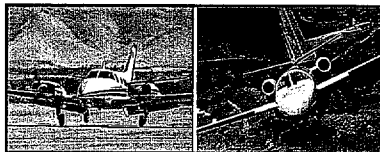


AIRCRAFT MIX



OPERATIONS

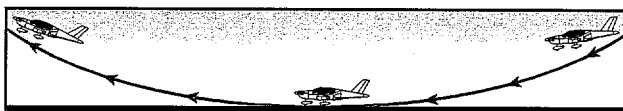
Arrivals and Departures



Total Annual Operations



Touch-and-Go Operations



TUCSON
AIRPORT AUTHORITY

Exhibit 3B
AIRFIELD CAPACITY
FACTORS

available for use during instrument weather conditions, capacity is less. This is a minor overall decrease, however, because of the high percentage of visual weather in the Tucson area. The existing parallel runway configuration in combination with the crosswind provides for maximum capacity by providing for simultaneous operations to different runways during visual conditions.

• Runway Use

Runway use is normally dictated by wind conditions. The direction of takeoffs and landings is generally determined by the speed and direction of wind. It is generally safest for aircraft to takeoff and land into the wind, avoiding a crosswind (wind that is blowing perpendicular to the travel of the aircraft) or tailwind components during these operations. Ryan Airfield's noise abatement procedures call for the east traffic flow on the parallel runways with up to a 10 knot tailwind. The paving of Runway 15-33 will permit this runway to be used by more aircraft in crosswind conditions.

• Exit Taxiways

Exit taxiways have a significant impact on airfield capacity since the number and location of exits directly determines the occupancy time of an aircraft on the runway. Each runway at Ryan Airfield has several exit taxiways available for use. The airfield capacity analysis gives credit to exits located within a prescribed range from a runway's threshold. This range is based upon the

mix index of the aircraft that use the runway. For the existing and future mix at Ryan Airfield, this range is between 2,000 and 4,000 feet from the threshold. The exits must be at least 750 feet apart to count as separate exits. Under this criteria, Runway 6R-24L is credited with three exits and Runway 6L-24R and Runway 15-33 are credited with two each.

Meteorological Conditions

Weather conditions can have a significant affect on airfield capacity. Airport capacity is usually highest in clear weather, when flight visibility is at its best. Airfield capacity is diminished as weather conditions deteriorate and cloud ceilings and visibility are reduced. As weather conditions deteriorate, the spacing of aircraft must increase to provide allowable margins of safety. The increased distance between aircraft reduces the number of aircraft which can operate at the airport during any given period. This consequently reduces overall airfield capacity.

There are three categories of meteorological conditions each defined by the reported cloud ceiling and flight visibility. Visual Flight Rule (VFR) conditions exist whenever the cloud ceiling is greater than 1,000 feet above ground level, and visibility is greater than three statute miles. VFR flight conditions permit pilots to approach, land, or take off by visual reference and to see and avoid other aircraft.

Instrument Flight Rule (IFR) conditions exist when the reported ceiling is less

than 1,000 feet above ground level and/or visibility is less than three statute miles. Under IFR conditions pilots must rely on instruments for navigation and guidance to the runway. Other aircraft cannot be seen so safe separation between aircraft must be assured solely by following air traffic control rules and procedures. As mentioned, this leads to increased distances between aircraft which diminishes airfield capacity.

Poor Visibility Conditions (PVC) exist when the cloud ceiling and/or visibility is less than cloud ceiling and visibility minimums prescribed by the instrument approach procedures for the airport. Because it is below minimums, the airport is essentially closed to arrivals during PVC conditions.

According to weather observations data from Tucson International Airport, VFR conditions prevail approximately 99 percent of the time, whereas IFR conditions occur just one percent of the time, and PVC is negligible for this analysis.

Aircraft Mix

Aircraft mix refers to the speed, size, and flight characteristics of aircraft operating at the airport. As the mix of aircraft operating at an airport increases to include larger aircraft, airfield capacity begins to diminish. This is due to larger separation distances that must be maintained between aircraft of different speeds and sizes.

Aircraft mix for the capacity analysis is defined in terms of four aircraft classes. Classes A and B consist of single and multi-engine aircraft weighing less than 12,500 pounds. Aircraft within these classifications are primarily associated with general aviation operations, but does include some business turboprop and business jet aircraft (e.g. the Cessna Citation business jet and Beechcraft King Air). Class C consists of multi-engine aircraft weighing between 12,500 and 300,000 pounds. This is broad classification that includes business jets, turboprops, and large commercial airline aircraft. Most of the business jets in the national fleet are included within this category. Class D includes all aircraft over 300,000 pounds and includes wide-bodied and jumbo jets. **Exhibit 3B** depicts representative aircraft in each aircraft class.

For the capacity analysis, the percentage of Class C and D aircraft operating at the airport is critical in determining the annual service volume as this class includes the larger and faster aircraft in the operational mix. The existing and projected operational fleet mix for the airport is summarized in **Table 3B**. Consistent with projections prepared in the previous chapter, the operational fleet mix at the airport is expected to slightly increase its percentage of Class C aircraft through the planning period as corporate aircraft activities increase through the planning period.

TABLE 3B
Aircraft Operational Mix

	A & B	C	D
Existing (1998)	98.8%	1.2%	0.0%
Short Term	98.2%	1.8%	0.0%
Intermediate Term	97.1%	2.1%	0.0%
Long Term	97.6%	2.4%	0.0%

Demand Characteristics

Operations, not only the total number of annual operations, but the manner in which they are conducted, have an important effect on airfield capacity. Peak operational periods, touch-and-go operations, and the percent of arrivals impact the number of annual operations that can be conducted at the airport.

• Peak Period Operations

For the airfield capacity analysis, average daily operations and average peak hour operations during the peak month is calculated. These operational levels were calculated previously in Chapter Two (Table 2H) for existing and forecast levels of operations. Typical operational activity is important in the calculation of an airport's annual service level as "peak demand" levels occur sporadically. The peak periods used in the capacity analysis are representative of normal operational activity and can be exceeded at various times through the year.

• Touch-and-Go Operations

A touch-and-go operation involves an aircraft making a landing and an

immediate take-off without coming to a full stop or exiting the runway. These operations are normally associated with training operations and are included in local operations data recorded by the air traffic control tower. Touch-and-go activity is counted as two operations since there is an arrival and a departure involved. A high percentage of touch-and-go traffic normally results in a higher operational capacity because one landing and one takeoff occurs within a shorter time than individual operations. Touch-and-go operations currently account for approximately 55 percent of annual operations. According to the operations forecasts, this percentage is anticipated to decrease slightly to approximately 52 percent over the planning period.

• Percent Arrivals

The percentage of arrivals as they relate to the total operations in the design hour is important in determining airfield capacity. Under most circumstances, the lower the percentage of arrivals, the higher the hourly capacity. There is no specific data available on the arrival/departure split at Ryan Airfield. Normally, arrivals and departures balance evenly, especially on general aviation airports.

According to airport tower personnel, they believe this to be the case at Ryan Airfield, so 50 percent arrivals were assumed for the purposes of this study.

Capacity Analysis

The preceding information was used in conjunction with the airfield capacity methodology developed by the FAA to determine airfield capacity for Ryan Airfield.

• HOURLY RUNWAY CAPACITY

The first step in determining annual service volume involves the computation of the hourly capacity of each runway use configuration. The percentage use of each runway, the amount of touch-and-go training activity, and the number and locations of runway exits become important factors in determining the hourly capacity of each runway configuration.

As the mix of aircraft operating at an airport changes to include a greater utilization of Class C and D aircraft, the hourly capacity of the runway system is reduced. This is because larger aircraft require longer utilization of the runway for takeoffs and landings, and because the greater approach speeds of the aircraft require increased separation. This contributes to a slight decline in the hourly capacity of the runway system over the planning period.

Considering the existing runway system, the existing and forecast aircraft mix, a touch-and-go factor of 50 percent, and the taxiway exit rating of

the existing runway, the hourly capacity was computed. The existing maximum hourly capacity during VFR conditions totaled 267 operations per hour, while IFR operations totaled 67 operations per hour.

The percentage of Class C aircraft is projected to increase slightly over the long range planning horizon. This factor contributes to a slight decline in the hourly capacity of the runway system. In the long range, the maximum hourly capacity of the current runway system under VFR conditions will decline to 263 operations. This capacity, however, will not be exceeded by design hour demand within the planning period. During periods of IFR, operations at the airport decline significantly as training operations are suspended and other pilots who are not instrumented-rated must also suspend activity. Thus the operations typically decline by 70 percent or more at general aviation airport, so the IFR hourly capacity at Ryan Airfield will also be adequate for the planning period.

The weighted hourly capacity averages the hourly capacities of the runway in VFR, IFR, and PVC conditions. The results of this analysis are presented in **Table 3C**.

• ANNUAL SERVICE VOLUME

Once the weighted hourly capacity is known, the annual service volume (ASV) can be determined. ASV, the annual airfield capacity for planning purposes, is calculated by the following equation:

$$ASV = C \times D \times H$$

C = Weighted hourly capacity

D = Ratio of annual demand to average daily demand

H = Ratio of average daily demand to average peak hour demand

The current ratio of annual demand to average daily demand (D) was determined to be 313. This is expected to remain relatively constant over the long range planning period. The ratio of average daily demand to average peak hour demand (H) was determined to be 6.65 in 1998. As operations increase, the percentage of operations in the peak hour is expected to decrease. This occurs because operations will tend to spread more throughout the day, becoming less concentrated in any given

hour. In the long range planning horizon the daily demand ratio was forecast to be 310, and the peak hour demand ratio was forecast to reach 7.72.

The current ASV for Ryan Airfield was determined to be 387,000 operations. Although Class C mix will increase slightly over the planning period, the increase in the hourly ratio contributes to an ASV increase to 438,000 operations over the long range. With operations in 1998 totaling 156,000, the airport is currently at 40 percent of its annual service volume. Long range annual operations are forecast to reach 261,000 operations which would equal just under 60 percent of the airport's ASV. **Table 3C** summarizes the airport's ASV over the long range planning horizon.

TABLE 3C
Annual Service Volume Comparison

	Annual Operations	Weighted Hourly Capacity	Annual Service Volume	Percent Capacity	Total Annual Hours of Aircraft Delay
Existing (1998)	156,000	186	387,000	40.3%	650
Short Term	184,000	185	409,000	45.0%	920
Intermediate Term	208,000	184	416,000	50.0%	1,283
Long Term	261,000	183	438,000	59.6%	2,132

Delay

As the number of annual aircraft operations approaches the airfield's capacity, increasing amounts of delay to aircraft operations begin to occur. Delays occur to arriving and departing aircraft in all weather conditions. Arriving aircraft delays result in

aircraft holding outside of the airport traffic area. Departing aircraft delays result in aircraft holding at the runway end until released by the air traffic control tower.

Table 3C summarizes the aircraft delay analysis conducted for Ryan Airfield. Current delay is a minimal 650

hours. As an airport's operations increase, delay increases exponentially. Analysis of delay factors for the long range planning horizon indicate that annual delay can be expected to reach 2,132 hours. This level of delay is still very limited indicating that Ryan Airfield has adequate airfield capacity for the long range planning horizon and beyond.

Conclusion

Exhibit 3C compares annual service volume to existing and forecast operational levels at Ryan Airfield. The 1998 total of 156,000 operations represented 40 percent of the airfield's annual service volume. By the end of the planning period total annual operations are expected to represent just under 60 percent of annual service volume.

FAA Order 5090.3B, **Field Formulation of the National Plan of Integrated Airport Systems (NPIAS)**, indicates that improvements for airfield capacity purposes should begin to be considered once operations reach 60 percent of the annual service volume. Should operations occur as forecast, the airport will only begin to reach this threshold at the very end of the long range planning period. Thus, adequate airfield capacity is available at Ryan Airfield for the reasonable planning horizon.

RUNWAYS

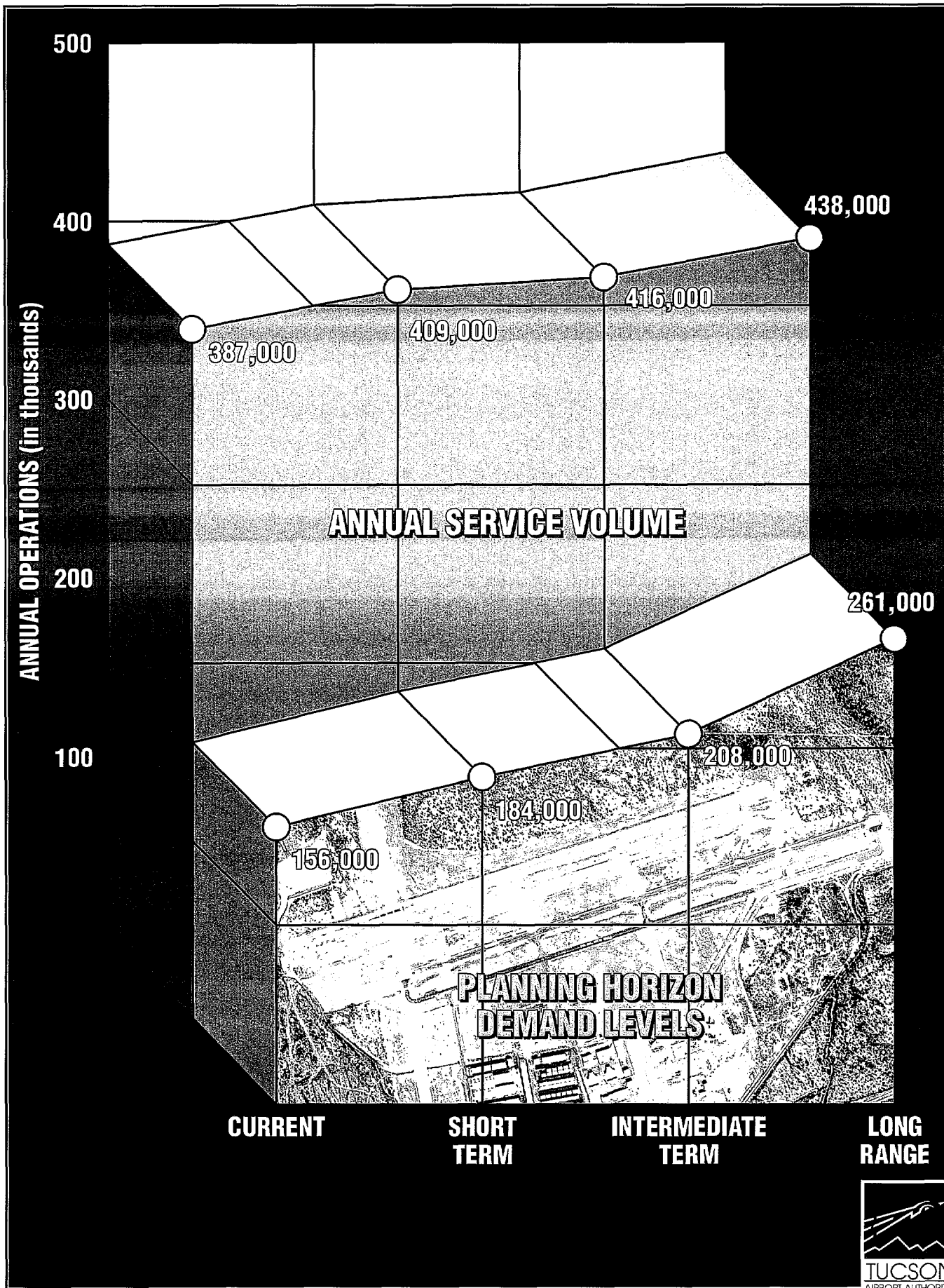
The adequacy of the existing runway system at Ryan Airfield has been analyzed from a number of perspectives, including airfield capacity, runway orientation, runway length, pavement strength, and runway dimensional design standards. From this information, requirements for potential runway improvements have been determined for the airport.

Runway Orientation

The airfield capacity analysis in the previous section indicated that the existing runway configuration will provide adequate airfield capacity for the planning horizon and beyond. This includes parallel runways and a crosswind runway that is being paved in 1999.

With adequate operational capacity, the next consideration is the capability of the airport to remain operational in adverse wind conditions. Ideally, the primary runway at an airport should be oriented as close as practical in the direction of the predominant winds to maximize the runway's usage. This minimizes the percent of time that a crosswind could make the preferred runway inoperable.

FAA Advisory Circular 150/5300-13, **Change 1, Airport Design** recommends that a crosswind runway



should be made available when the primary runway orientation provides less than 95 percent wind coverage for any aircraft forecast to use the airport on a regular basis. The 95 percent wind coverage is computed on the basis of the crosswind component not exceeding 10.5 knots (12 mph) for Airport Reference Codes (ARC) A-I and B-I; 13 knots (15 mph) for ARC A-II and B-II; and 16 knots (18 mph) for ARC A-III, B-III, and C-I through D-II.

An analysis of historical wind data from Tucson International Airport over a recent ten-year period (1988-1997) provides information for this study. This data is graphically depicted on the wind rose in **Exhibit 3D**.

As depicted on the exhibit, runway orientation 6-24 provides 91.3 percent coverage for 10.5 knot crosswinds, 95.7 percent at 13 knots, and 99.1 percent at 16 knots. Thus, the primary runway orientation does not provide adequate wind coverage for A-I and B-I aircraft, and provides marginally adequate coverage for B-II aircraft.

Crosswind Runway 15-33 increases the airfield's wind coverage to 97.6 percent for 10.5 knot crosswinds, 99.3 percent at 13 knots. The crosswind runway is necessary to meet the wind coverage design standards for A-I and B-I aircraft. Although technically not necessary for A-II and B-II standards, the availability of the crosswind runway for these aircraft would improve wind coverage 3.4 percent. This additional coverage would be advantageous especially for small aircraft (weighing

less than 12,500 pounds) in the B-II ARC. For this reason, it is recommended that crosswind runway be planned to accommodate small aircraft in ARC B-II.

Runway Length

The determination of runway length requirements for the airport are based on five primary factors:

- Critical aircraft type expected to use the airport.
- Stage length of the longest nonstop trip destinations.
- Mean maximum daily temperature of the hottest month.
- Runway gradient.
- Airport elevation.

An analysis of the existing fleet mix indicates that cabin-class twin-engine aircraft in ARC B-I are currently the critical aircraft for runway length at Ryan Airfield. In the future, growth in business jet activity will make these aircraft the most critical.

Aircraft operational efficiency declines as the temperature, airport elevation, and runway gradient increase. The mean maximum daily temperature of the hottest month at Ryan Airfield is 98.5 degrees Fahrenheit. The airport elevation is 2,415 feet above mean sea level (MSL). Gradient for Runway 6R-24L is 0.11.

Table 3D outlines the runway length requirements specific to Ryan Airfield's conditions for the various classifications of general aviation aircraft. These standards were derived from the **FAA Airport Design Computer Program** for recommended runway lengths. As with other design criteria, runway length requirements are based upon the

critical aircraft grouping with at least 500 annual operations.

According to the table a runway length of 4,800 feet will accommodate 100 percent of the small airplanes. This runway length is adequate to accommodate all small aircraft up to ARC B-II.

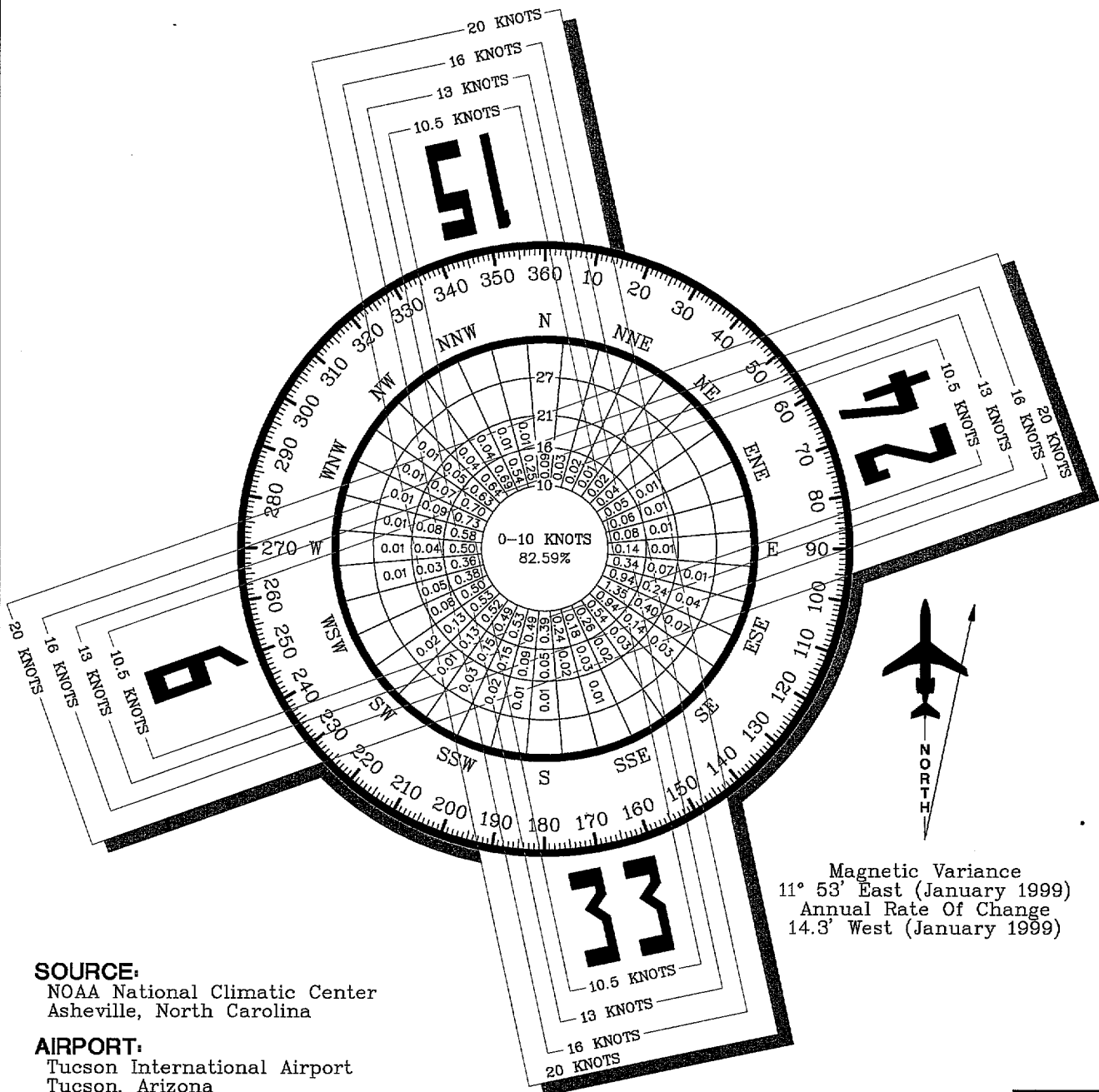
TABLE 3D	
Runway Length Analysis	
Ryan Airfield	
AIRPORT AND RUNWAY DATA	
Airport elevation	2,415 feet
Mean daily maximum temperature of the hottest month	98.5° F
Maximum difference in runway centerline elevation	10 feet
RUNWAY LENGTHS RECOMMENDED FOR AIRPORT DESIGN	
Small airplanes with less than 10 passenger seats	
75 percent of these small airplanes	3,500 feet
95 percent of these small airplanes	4,200 feet
100 percent of these small airplanes	4,800 feet
Small airplanes with 10 or more passenger seats	4,900 feet
Large airplanes of 60,000 pounds or less	
75 percent of business jets at 60 percent useful load	5,500 feet
100 percent of business jets at 60 percent useful load	7,200 feet
75 percent of business jets at 90 percent useful load	8,300 feet
100 percent of business jets at 90 percent useful load	10,200 feet
REFERENCE: FAA's airport design computer software utilizing Chapter Two of AC 150/5325-4A, Runway Length Requirements for Airport Design , no Changes included.	

The table also outlines the runway length requirements for the future critical aircraft. The present runway length of 5,500 feet is adequate to accommodate 75 percent of the business jet fleet at a useful load of 60 percent. Thus, the current runway length is adequate for some use by a number of

business jet aircraft. To accommodate a full range of business jet activity at 60 percent useful load, however, a runway length of 7,200 feet will be needed. This would permit the airport to accommodate aircraft such as the Gulfstream and Bombardier Challenger series of business jets.

ALL WEATHER WIND COVERAGE

RUNWAYS	10.5 KNOTS	13 KNOTS	16 KNOTS	20 KNOTS
Runway 6-24	91.29%	95.73%	99.12%	99.85%
Runway 15-33	92.02%	96.02%	98.96%	99.81%
Combined	97.55%	99.29%	99.87%	99.99%



SOURCE:

NOAA National Climatic Center
Asheville, North Carolina

AIRPORT:

Tucson International Airport
Tucson, Arizona

OBSERVATIONS:

87,644 All Weather Observations
1988 - 1997



TUCSON
AIRPORT AUTHORITY

Exhibit 3D
WINDROSE ANALYSIS

To accommodate longer range flights such as nonstop flights to the east coast, the useful load would need to be increased to 90 percent for 75 percent of the business jets. As indicated on the table, this would require a runway length of 8,300 feet. It is not anticipated that 100 percent of the fleet at 90 percent useful load would need to be accommodated, because this length typically represents long range international trips. Based upon the future critical aircraft and the desired haul lengths, the primary runway length at Ryan Airfield should ultimately be planned for 8,300 feet.

The purpose of the parallel runway is to provide additional airfield capacity. To do this effectively, the parallel runway should be capable of serving at least 90 percent of the operational fleet mix at the airport. Comparing to **Table 3D**, the present runway length of 4,900 feet can accommodate the full range of small airplanes. These aircraft will comprise over 90 percent of the operations at Ryan Airfield in the future. Therefore, the current length of the parallel runway will be adequate for the long range planning horizon.

As indicated under the runway orientation analysis, the crosswind runway should be designed to accommodate aircraft in ARC B-I and if possible, B-II. This would indicate a runway length of 4,800 feet would be desirable. FAA Advisory Circular 150/5325-4A **Runway Length Requirements for Airport Design** suggests that a crosswind runway should have a length of at least 80 percent of the design length. The 4,000 foot runway being constructed in 1999 will meet this rule-of-thumb criteria.

Runway Strength

The runway pavement strengths were first mentioned in the **Chapter One - Inventory**. Runway 6R-24L and Runway 6L-24R each have a pavement strength rating of 12,500 pounds single wheel loading (SWL) and 30,000 pounds single wheel loading (DWL). Crosswind Runway 15-33 has been designed to be 12,500 pounds SWL when it is paved. A recent pavement management study indicated that the primary runway is in poor condition while the parallel runway is in very good condition.

The heaviest aircraft currently using the airport is the C-54 (DC-4) used in aerial firefighting under contract to the U.S. Forest Service. The maximum takeoff weight of this aircraft is 73,000 pounds on dual wheel gear. As mentioned earlier, the airport critical aircraft could eventually become larger business jets such as the Gulfstream IV. This aircraft has dual wheel gear and a maximum takeoff weight 72,000 pounds. Based upon the existing and future critical aircraft, the primary runway at Ryan Airfield should be designed to a pavement strength of 73,000 pounds DWL in the short term.

The parallel runway should be planned to accommodate at least 90 percent of the airport's operational fleet mix. The present pavement strength is adequate for this use. The crosswind runway is primarily necessary for small aircraft weighing less than 12,500 pounds. Therefore, its current design strength will also be adequate for the planning period.

Runway Dimensional Design Standards

Runway dimensional design standards define the widths, and clearances required to optimize the safe operation in the landing and takeoff area. These dimensional standards vary depending upon the ARC for each runway. **Table 3E** outlines key dimensional standards for the airport reference codes most applicable to Ryan Airfield now and in the future.

As indicated earlier, the primary runway at Ryan Airfield should currently be designed to B-III standards and planned to be upgraded to incorporate D-II standards in the future. The parallel runway should be designed to B-II standards both now and in the future. The crosswind runway will need to meet B-I standards for small aircraft at a minimum. It has been recommended, however, that B-II standards be considered for this runway because of the additional wind coverage that can be gained.

Each of the runways is currently 75 feet wide (including Runway 15-33 which is being constructed that width). Based upon the current ARC of B-III, the primary runway width should be 100 feet. This width will also be adequate for a future upgrade to D-II. The 75 foot width will be adequate for the parallel and crosswind runways.

Other upgrades that will be necessary include the placement of the runway holding position markings on the taxiways entering the parallel runways, and the runway safety area (RSA) and object free area (OFA) dimensions of the

primary runway. The holding positions to the primary runway are presently marked 200 feet from the runway centerline. This is adequate for B-III with the current instrument approach minimums. Upgrading the runway to D-II or to Category I approach minimums (less than 3/4 miles), will require the holding position markings to be moved back to 250 feet from the runway centerline.

The holding position markings to the parallel runway are presently 125 feet from the runway centerline. This is adequate for runways serving small aircraft exclusively. If the runway is to serve aircraft over 12,500 pounds in the future, the holding positions will need to be remarked at 200 feet from the centerline. Because the crosswind runway is to serve small aircraft, 125 foot holding position markings will be adequate.

The RSA and OFA on the primary runway presently meet B-II dimensional standards. This will need to be widened and extended as indicated on the table to meet either B-III or D-II standards.

Taxiways

Taxiways are constructed primarily to facilitate aircraft movements to and from the runway system. Some taxiways are necessary simply to provide access between the aprons and runways, whereas other taxiways become necessary as activity increases at an airport to provide safe and efficient use of the airfield.

TABLE 3E
Airfield Design Standards
Ryan Airfield

Airport Reference Code	Small Aircraft B-I (ft.)	B-II (ft.)	B-III (ft.)	D-II (ft.)
Runway Width	60	75	100	100
Runway Safety Area				
Width	120	150	400	540
Length Beyond End	240	300	800	1,000
Runway Object Free Area				
Width	250	500	800	800
Length Beyond End	240	300	800	1,000
Runway Centerline to:				
Holding Position	125	200	200*	250
Parallel Taxiway	150	240	350	400
Parallel Runway	700	700	700	700
Taxiway Width	25	35	50	35
Taxiway Centerline to:				
Fixed or Movable Object	44.5	65.5	93	65.5
Parallel Taxilane	69	105	152	105
Taxilane Centerline to:				
Fixed or Movable Object	39.5	57.5	81	57.5
Parallel Taxilane	64	97	140	97
Runway Protection Zones -				
One mile or greater visibility				
Inner width	250	500	500	500
Length	1,000	1,000	1,000	1,700
Outer width	450	700	700	1,010
Category I				
Inner Width	N/A	N/A	1,000	1,000
Length	N/A	N/A	2,500	2,500
Outer Width	N/A	N/A	1,750	1,750

* For 3/4 mile or greater visibility. Lower visibility requires 250 ft.

As detailed in Chapter One, both Runways 6R-24L and 6L-24R are served by full length parallel taxiways, and an array of exit taxiways. Runway 15-33 is being constructed with a full length parallel taxiway as well.

Acute angle, or high speed, exits can provide the ability for an aircraft to clear the runway faster, thereby increasing airfield efficiency. According to FAA Advisory Circular 150/5300-13, Change 5, Appendix 9, high speed exits beginning at 5,000 to 6,000 feet from the runway threshold would be usable

by business jet aircraft. Acute angle exits located 2,000 to 2,500 feet from the runway threshold would be optimum for use by the single engine aircraft that dominates activity at Ryan Airfield. High speed exits for the single and light twin aircraft should be considered for the primary and parallel runways.

Bottlenecks can often occur near the takeoff end of a runway when a preceding aircraft is not ready to takeoff and blocks the access taxiway for the aircraft next in line. This can be a very common occurrence at airports such as Ryan Airfield where there is a high amount of training activity. Holding bays provide flexibility in ground circulation by permitting departing aircraft to maneuver around an aircraft that is not ready to depart. Holding bays are recommended when runway operations exceed 30 per hour. Holding bays are currently available at each end of the parallel runways. They should also be planned for the ends of the crosswind runway.

Other taxiways connect the airfield with the terminal area. Because of the significant amount of stored aircraft and the length of taxi necessary to reach the airfield system, there is a high potential for traffic circulation congestion in these areas. At present, several holding bays are strategically located to alleviate this problem. As traffic increases and the terminal area is infilled with additional storage and fixed base operator activity, dual taxiway systems may need to be considered over the long range.

Table 3E outlines the dimensional design standards for taxiways based upon the ARC to be served at Ryan Airfield. The width of existing taxiways varies between 30 and 50 feet. In order to accommodate Design Group III aircraft, FAA criteria calls for a taxiway width of 50 feet. This taxiway width and other Group III standards should be met along taxiways to be regularly utilized by the C-54 aircraft. Currently, the parallel taxiway and exits to the primary runway meet the 50-foot width standard. Taxiways serving Design Group II should be 35 feet wide. The taxiways serving the parallel runway meet this criteria. The parallel taxiway to Runway 15-33 will also meet this criteria. In areas where only Group I aircraft will circulate, a 25 foot taxiway will be adequate.

Most of current holding bays offer minimal separation from the adjacent taxiways. This separation should be increased to meet the separation standards of B-III along the primary runway, and Group II in other locations.

Navigational Aids and Lighting

Airport and runway navigational aids are based on FAA recommendations as depicted in DOT/FAA Handbook 7031.2B, **Airway Planning Standard Number One** and FAA Advisory Circular 150/5300-13, **Airport Design**.

Navigational aids provide two primary services to airport operations: precision guidance to specific runway, and/or non-

precision guidance to a runway or the airport itself. The basic difference between a precision and non-precision navigational aid is that the former provides electronic descent, alignment (course), and position guidance, while the non-precision navigational aid provides only alignment and position location information. The necessity of such equipment is usually determined by design standards predicated on safety considerations and operational needs. The type, purpose and volume of aviation activity expected at the airport are factors in the determination of the airport's eligibility for navigational aids.

● INSTRUMENT APPROACHES

The advancement of technology has been one of the most important factors in the growth of the aviation industry in the twentieth century. Much of the civil aviation and aerospace technology has been derived and enhanced from the initial development of technological improvements for military purposes. The use of orbiting satellites to confirm an aircraft's location is the latest military development to be made available to the civil aviation community.

Global positioning systems (GPS) use two or more satellites to derive an aircraft's location by a triangulation method. The accuracy of these systems has been remarkable, with initial degrees of error of only a few meters. As the technology improves, it is anticipated that GPS may be able to provide accurate enough position information to allow Category II and III

precision instrument approaches, independent of any existing ground-based navigational facilities. In addition to the navigational benefits, it has been estimated that GPS equipment will be much less costly than existing precision instrument landing systems.

Due to 99 percent VFR weather, Ryan Airfield's needs for instrument approaches are primarily based upon training activity. Currently, Ryan Airfield is served by an instrument landing system (ILS) approach, an NDB/DME approach, and a GPS overlay approach, all to Runway 6R. The ILS approach provides the best weather minimums allowing the airport to remain operational with reported cloud ceilings of at least 200 feet and 3/4 mile visibility. Ultimately, attaining Category I minimums of one-half mile visibility should be considered. This would require the addition of a medium intensity approach lighting system with runway alignment indicator lights (MALSR).

With the evolution of GPS, it is likely that Ryan Airfield will have the opportunity to be served by stand-alone GPS instrument approaches in the future. A Category I approach to Runway 6R should still be planned. Higher minimum approaches can be added to the other runways with minimal cost as long as airfield design standards are met. Therefore, all runways at the airport should be planned for GPS approaches of one mile or greater visibility. Runway 24L should be considered for a 3/4 mile approach as a back-up to the CAT I approach to Runway 6R. This would

require approach lights such as a short approach light system (SALS).

- **AIRPORT VISUAL
APPROACH AIDS**

Visual glide slope indicators (VGSI) are a system of lights located at the side of the runway which provide visual descent guidance information during an approach to the runway. Presently Runway 24L is equipped with four-box visual approach path indicators (VASI-4). The two-box systems are adequate for Approach Category B aircraft, but four-box systems are needed for Category C and D aircraft use. Precision approach path indicators (PAPI's) are the typical VGSI and now installed when federal funds are involved. Each runway end should be planned for PAPI or an equivalent VGSI.

- **AIRFIELD LIGHTING
AND MARKING**

Runway identification lighting provides the pilot with a rapid and positive identification of the runway end. The most basic system involves runway end identifier lights (REIL's). REIL's should be considered for all lighted runways not planned for a more sophisticated approach light system (ALS). Currently, REILs are installed at the approach threshold of Runway 6R. REIL's should be planned for all the other runway ends at Ryan Airfield.

As previously mentioned, Runway 6R could be upgraded to a full Category I instrument approach if the existing

REIL's were replaced with MALSR or equivalent system. This is recommended for training activity and future increases in corporate use. An approach light system such as an SALS should be planned for a 3/4 mile approach to Runway 24L.

The medium intensity runway lighting (MIRL) currently serving Runway 6R-24L respectively will be adequate for the planning period. The parallel and crosswind runway should also be planned for MIRL. Presently the taxiway system is marked by taxiway reflectors. An upgrade to medium intensity taxiway lighting (MITL) should be considered over the planning period. Lighted taxiway signage to the primary runway should also be planned. Precision runway marking should be maintained on Runway 6R, as well as the non-precision markings on Runway 24L. Visual or basic runway markings will continue to be adequate for the parallel and crosswind runways.

The airport also presently has a lighted wind cone and segmented circle which provides pilots with information about wind conditions and the airport traffic pattern. In addition, an airport beacon assists in identifying the airport from the air at night. Each of these facilities should be maintained in the future.

- **AUTOMATED WEATHER
REPORTING SYSTEM**

Two types of automated weather observing systems are currently deployed at airports around the country. ASOS (automated surface observing

system) and AWOS (automated weather observing system) both measure and process surface weather observations 24 hours a day, with reporting varying from one minute to hourly. The systems provide near real-time measurements of atmospheric conditions.

ASOS is typically commissioned by the National Weather Service or the Department of Defense. AWOS is often commissioned by the Federal Aviation administrations for airports that meet criteria of either 8,250 annual itinerant operations or 75,500 annual local operations. Ryan Airfield qualifies and is currently served by an AWOS-3 on site.

- **AIRPORT TRAFFIC
CONTROL TOWER**

Ryan Airfield is presently served by an airport traffic control tower (ATCT) operated on a contract basis. The FAA has established criteria for qualifying for an FAA operated ATCT. Based upon the projected airport operational levels, Ryan Airfield would qualify at the operational levels of the intermediate planning horizon.

LANDSIDE REQUIREMENTS

Landside facilities are those necessary for handling of aircraft, passengers, and cargo while on the ground. These facilities provide the essential interface between the air and ground transportation modes. The capacities of the various components of each area were examined in relation to projected

demand to identify future landside facility needs during the planning period for the following types of facilities normally associated with general aviation terminal areas:

- Hangars
- Aircraft Parking Apron
- General Aviation Terminal Services
- Access and Vehicle Parking
- Fuel Storage

HANGARS

The demand for hangar facilities typically depends on the number and type of aircraft expected to be based at the airport. Hangar facilities are generally classified as shade hangars, T-hangars, or conventional hangars. Conventional hangars can include individual hangars or multi-aircraft hangars. These different types of hangars offer varying levels of privacy, security, and protection from the elements.

Typical utilization of hangar space varies across the country as a function of local climate conditions, airport security, and owner preferences. The hangar storage requirements at Ryan Airfield were estimated after reviewing the responses to a survey of Pima County aircraft owners conducted previously as part of the **Tucson International Airport General Aviation Strategic Plan**. Approximately 70 percent of the single and twin engine aircraft at Ryan Airfield aircraft are presently stored in shade or enclosed hangars. A significantly higher percentage (93 percent) of aircraft owners in Pima

County, however, indicated a preference for hangar space. Since some hangar space is available at Ryan Airfield, the large discrepancy can be attributed, at least in part, to the unwillingness of some owners to pay the higher costs of hangar storage, and the fact that the flight training school does not hangar most of its aircraft.

The intense summer weather conditions in Tucson places a premium on sheltered parking. Weather is not the only factor that influences the demand for hangar storage. The larger, more sophisticated and more expensive aircraft tend to be stored in hangars. Owners of these types of aircraft normally desire hangar space to protect their investment.

Based upon the owner preferences, it was estimated that the percent of the piston aircraft to be hangared would gradually grow to eighty-five (85) percent. Further, all turbine, as well as rotorcraft aircraft would be hangared.

The survey also indicated that the majority of owners (85 percent) would prefer either T-hangars or individual hangars over multi-aircraft hangars. This shows a strong desire on the part of the owners to keep their aircraft within individualized hangar space. Besides T-hangars this can typically include condominium-type clear span hangars, executive or corporate hangars.

For planning purposes, shade hangar usage was projected to decrease from 30 percent to 25 percent of piston aircraft over the planning period. T-hangar usage was projected to increase from 27

percent to 40 percent. The remainder of the aircraft would be stored in conventional hangars such as executive or corporate hangars or larger, multi-aircraft hangars. **Table 3F** depicts the future hangar position preferences at Ryan Airfield.

The final step in the process of determining hangar requirements involves estimating the area necessary to accommodate the required hangar space. A planning standard of 800 square feet per shade hangar space and 1,250 square feet per based aircraft stored in T-hangars was used. Planning figures for conventional hangars indicate an area of 1,500 square feet for piston and rotary aircraft and 2,500 square feet for turbine aircraft. These figures were applied to the aircraft to be hangared in conventional and T-hangars to determine the area to be devoted to hangar facility requirements through the planning period. Requirements for maintenance and shop hangar area were estimated at 175 square feet per based aircraft.

Table 3F compares the existing hangar availability to the future hangar requirements. It is evident from the table, there could be a need for additional enclosed hangar storage space in the short term. The analysis also indicates a potential need for additional maintenance hangar space beyond the short term.

AIRCRAFT PARKING APRON

Parking apron should be provided for at least the number of locally-based air-

TABLE 3F
Hangar Requirements

	Available	Current Need	Short Term	Intermediate Term	Long Range
Based Aircraft					
Piston		232	258	280	334
Turbine		0	4	8	14
Rotor		<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Total		234	265	292	353
Aircraft to be Hangared					
Piston		162	194	224	284
Turbine		0	4	8	14
Rotor		<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Total		164	201	236	303
Shade Hangar Positions*	51	48	56	63	71
T-Hangar Positions	47	44	60	76	114
Conventional Hangar Positions**	81	70	85	97	118
Hangar Area (s.f.)					
Shade Hangar	40,800	38,000	45,000	50,000	57,000
T-Hangar	86,200	55,000	75,000	95,000	142,000
Conventional Hangars	<u>121,700</u>	<u>105,000</u>	<u>132,000</u>	<u>154,000</u>	<u>191,000</u>
Total Storage	248,700	198,000	252,000	299,000	390,000
Maintenance Hangars	44,000	41,000	46,000	51,000	62,000
* Nose shades are considered as tie-downs and are not included here.					
** Available positions estimated at 1,500 square feet per aircraft.					

craft that are not stored in hangars, as well as transient aircraft. As discussed in the previous section, approximately 15 percent of the based single engine aircraft owners will still prefer ramp storage over the long range. Therefore, the parking apron should be sized to accommodate this demand through the planning period. FAA planning criterion of 300 square yards per tie-down was used to estimate the ramp area that would be needed for based aircraft. The larger C-54 aircraft require approximately 3,500 square yards each. The number of local tie-

downs and ramp space for the planning period is presented in **Table 3G**.

FAA Advisory Circular 150/5300-13 suggests a methodology by which transient apron requirements can be determined from knowledge of busy-day operations. At Ryan Airfield, the number of transient spaces required was estimated to be approximately 25 percent of the busy day itinerant operations. Planning criterion of 500 square yards per aircraft was applied to the number of transient spaces to determine future transient apron

requirements. The transient apron space ratio is higher than that of the local apron, because it serves a larger variety of aircraft and is typically designed for taxi-through parking spaces.

The results of this analysis are presented in **Table 3G**. There is

approximately 78,300 square yards of parking apron located around the airport. As shown in the table, the existing apron area would be marginally adequate for the planning period. Another consideration will be the location of the apron in relation to other facilities.

TABLE 3G
Aircraft Parking Apron Requirements
Ryan Airfield

	Available	Current Need	Short Term	Intermediate Term	Long Range
Local Ramp					
Non-hangared Aircraft	80	70	64	56	50
Tie-down Area (s.y.)	41,800	34,000	32,000	30,000	28,000
Transient Ramp					
Busy Day Itinerant Ops	N/A	193	253	297	386
Transient Parking					
Positions	71	48	63	74	97
Apron Area (s.y.)	36,500	24,000	32,000	37,000	48,000
Total Parking Apron					
Positions	151	118	127	130	147
Apron Area (s.y.)	78,300	58,000	64,000	67,000	76,000

GENERAL AVIATION TERMINAL

A general aviation terminal can serve several functions including providing space for passenger waiting, pilot's lounge and flight planning, concessions, line service and airport management offices, storage, and various other needs. At most general aviation airports, these functions may not necessarily be limited to a single, separate terminal building, but can also be included in the space offered by fixed base operators for these functions and services. For purposes of this analysis, however, the space requirements will reflect that of a single, functional

terminal building. Space provided by multiple airport operators will generally increase the overall square footage requirements because of some duplication of function.

The existing airport administration building is located adjacent to the south ramp and includes approximately 850 square feet. Air Centers West has approximately 800 square feet of public terminal area available as well. The methodology used in estimating general aviation terminal facility needs was based on the number of itinerant passengers expected to utilize terminal facilities during the design hour and

FAA guidelines. A planning average of 1.8 passengers per itinerant flight increasing to 2.2 passengers per itinerant flight by the end of the planning period was multiplied by the number of design hour itinerant operations to determine design hour itinerant passengers.

Space requirements were then based upon providing 75 square feet per design hour itinerant passenger. **Table 3H** outlines the general space requirements for a public general aviation terminal at Ryan Airfield through the planning period. This

analysis indicates that the existing public terminal and administration facilities are undersized. If the airport is to consider a public terminal building in the future, it should be sized according to **Table 3H**. If restaurant facilities are to be considered, they would need to be added to this space requirement. The present restaurant at Ryan Airfield contains approximately 2,500 square feet. Multiple FBO offices and facilities and flight school classrooms would generally be in addition to the square footage indicated in the table as well.

TABLE 3H
General Aviation Terminal Building and Auto Parking
Ryan Airfield

	Available	Current Need	Short Term	Intermediate Term	Long Range
Design Hour Passengers	N/A	40	51	62	84
Terminal Space (s.f.)	1,650	3,000	3,800	4,700	6,300
Auto Parking Spaces	236	72	92	112	151

ACCESS AND PARKING

Access to Ryan Airfield is available from State Route 86 (Ajo Highway) to the east and west, and Valencia Road to the south. Both are two-lane rural highways in the vicinity of the airport. The long range transportation plans for the region call for Ajo Highway to be widened to four lanes in the future.

Using trip generation estimates from the **Institute of Transportation Engineers (ITE) Trip Generation Manual, 5th Edition**, Ryan Airfield is estimated to generate 2.6 daily vehicle trips per aircraft operation. Based upon

this ratio, design day trips can be expected to grow from 1,300 today to 2,200 over the long range planning horizon. This traffic level is not significant enough to require additional roadway capacity alone. Turn lanes may need to be considered in the future, however, to ensure safety.

On-airport access is provided by Aviator Lane and Airfield Drive. These roadways are two-lanes and should be adequate with proper maintenance. On-airport access and circulation, however, is impaired by the lack of an on-airport connector between the two main access roads. Public traffic

needing to move between Aviator Lane and Airfield Drive must utilize the highway. An on-airport circulation system should be considered to reduce the use of State Route 86 for this purpose.

Vehicle parking requirements have also been examined for Ryan Airfield. Space determinations were based on an evaluation of the existing airport use as well as industry standards. General aviation spaces were calculated by multiplying design hour itinerant passengers by the industry standard of 1.8. Auto parking requirements are summarized in **Table 3H**.

Approximately 236 automobile parking spaces are available on the airport. They are located along both Aviator Lane and Airfield Drive as well as at the restaurant and near the north apron. According to the analysis, there are adequate parking spaces available for the planning period. Another consideration, however, will be the location of adequate parking in relation to future facilities. Therefore, additional parking may be necessary.

FUEL STORAGE

The Tucson Airport Authority owns and operates two 12,000 gallon fuel tanks located adjacent to the south apron. Both tanks are used for storing 100 LL (avgas). Jet A is currently not available at Ryan Airfield. The fuel operation is self-service. The fuel facilities are in compliance with EPA and ADEQ standards.

Fuel storage requirements are typically based upon maintaining a one month supply of fuel during an average month, however, more frequent deliveries can reduce the fuel storage capacity requirement. Over the past six years, avgas fuel sales at Ryan Airfield have averaged 1.7 gallons per operation. This ratio was utilized to project future avgas sales. **Table 3J** presents future avgas storage requirements for the airport based upon a two week supply during the peak month.

TABLE 3J
Fuel Storage Requirements
Ryan Airfield

	Available	Current Need	Short Term	Intermediate Term	Long Range
Design Day Operations		499	587	671	842
Two Week Operations		6,986	8,218	9,394	11,788
Two-week Fuel Storage Requirements*					
Avgas (gal.)	24,000	11,200	14,400	16,400	20,600
Jet A (gal.)	0	1,000	2,800	5,600	9,000

* Note recommended minimum tank size – 12,000 gallons.

Projections of future Jet A fuel storage requirements were based upon an average sales per turbine operation at comparable general aviation reliever airports. A ratio of 25 gallons per turbine operation was used. Turbine operations were estimated at 500 annual operations per based turbine aircraft. Based upon these ratios turbine operations will reach 7,000 annually in the long range. **Table 3J** presents the Jet A fuel storage requirements.

It is anticipated that avgas storage will be adequate for the planning period. To better serve turbine aircraft at Ryan Airfield, it is recommended that Jet A fuel storage and dispensing be considered in the short term. To ensure that full truck loads of fuel can be accommodated, a minimum tank size of 12,000 gallons is recommended for each grade of fuel.

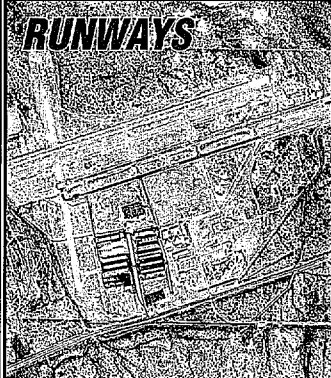
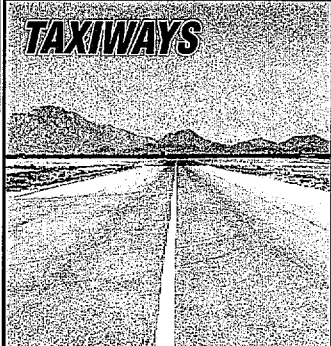
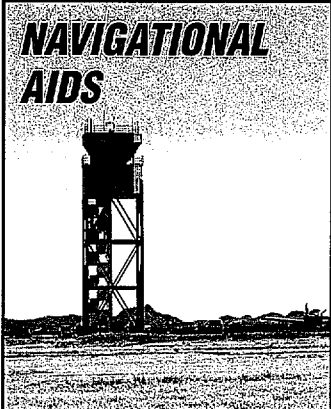
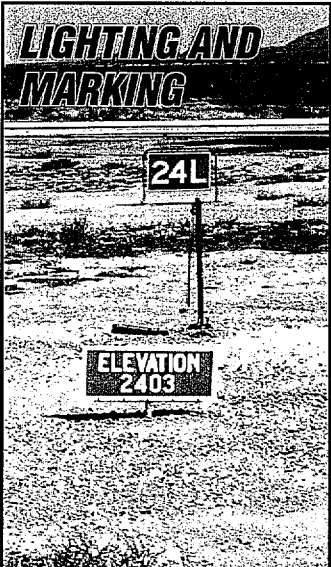
CONCLUSIONS

A summary of the airside and landside facility requirements analysis is presented on **Exhibits 3E and 3F**. To

accommodate business jet aircraft in the future, the primary runway will need to be upgraded. This will include an extension, widening, increased pavement strength, and improved safety areas.

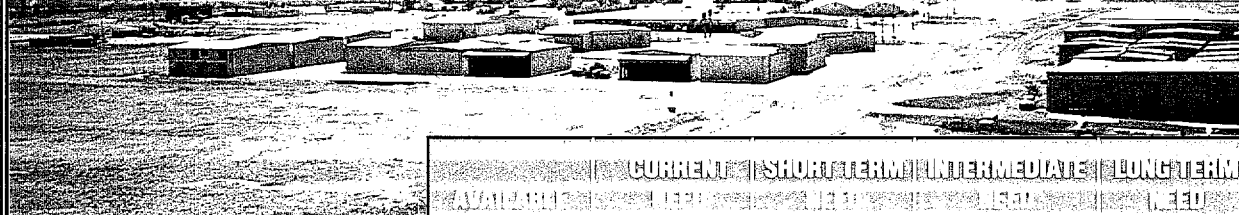
On the landside, additional hangar facilities will need to be planned for in the short term. There is a surplus of apron parking and auto parking available, however, the locations of this parking may not serve the long range needs of the airport from a convenience standpoint. Thus, a change of distribution will be necessary. Other considerations include two-way taxiway access for the hangar storage areas as well as expanded general aviation terminal facilities, Jet A fuel storage, and an on-airport connector road between the on-airport access roads.

The following chapter will formulate and analyze alternatives that can accommodate these requirements. These will then be reviewed and considered to recommend the best direction of future development of general aviation facilities at Ryan Airfield.

<i>RUNWAYS</i>	EXISTING	SHORT TERM	LONG RANGE
	<u>Runway 6R-24L</u> 5,500' x 75' 30,000# DWL	<u>Runway 6R-24L</u> 5,500' x 100' 73,000# DWL	<u>Runway 6R-24L</u> 8,300' x 100' 73,000# DWL
	<u>Runway 6L-24R</u> 4,900' x 75' 30,000# DWL	<u>Runway 6L-24R</u> Same	<u>Runway 6L-24R</u> Same
	<u>Runway 15-33</u> 3,547' x 75' Dirt	<u>Runway 15-33</u> 4,000' x 75' 12,500# SWL	<u>Runway 15-33</u> 4,800' x 75' 12,500# SWL
<i>TAXIWAYS</i>			
	<u>Runway 6R-24L</u> Full Parallel, 7 Exits 50' Wide	<u>Runway 6R-24L</u> Same	<u>Runway 6R-24L</u> Full Parallel, 9 Exits 50' Wide
	<u>Runway 6L-24R</u> Full Parallel, 5 Exits 35' Wide	<u>Runway 6L-24R</u> Same	<u>Runway 6L-24R</u> Same
	<u>Runway 15-33</u> Partial Parallel, 3 Exits 35' - 40' Wide	<u>Runway 15-33</u> Partial Parallel, 4 Exits 35' Wide	<u>Runway 15-33</u> Same
<i>NAVIGATIONAL AIDS</i>			
	ATCT Windcone AWOS-3 NDB	Same	ATCT Windcone AWOS-3
	<u>Runway 6R-24L</u> ILS (6R) NDB/DME (6R) GPS Overlay (6R) VASI-4 (24L)	<u>Runway 6R-24L</u> Same	<u>Runway 6R-24L</u> CAT I GPS (6R) GPS (24L) PAPI-4
			<u>Runway 6L-24R</u> GPS PAPI-4
			<u>Runway 15-33</u> GPS PAPI-4
<i>LIGHTING AND MARKING</i>			
	Airport Beacon Segmented Circle Taxiway Reflectors	Same	Airport Beacon Segmented Circle MITL
	<u>Runway 6R-24L</u> MIRL REIL's (6R) Precision Marking (6R) Non-Precision Marking (24L)	<u>Runway 6R-24L</u> MIRL REIL's Precision Marking (6R) Non-Precision Marking (24L)	<u>Runway 6R-24L</u> MIRL, REIL's MALSR (6R) SALS (24L) Precision Marking (6R) Non-Precision Marking (24L)
	<u>Runway 6L-24R</u> Basic Marking	<u>Runway 6L-24R</u> Basic Marking	<u>Runway 6L-24R</u> Basic Marking REIL's MIRL
	<u>Runway 15-33</u> None	<u>Runway 15-33</u> Basic Marking MIRL REIL's	<u>Runway 15-33</u> Same

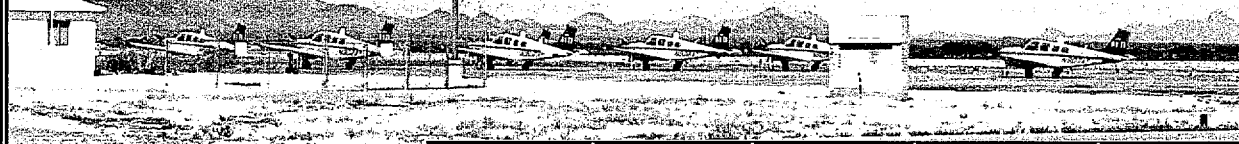


AIRCRAFT STORAGE HANGARS




	AVAILABLE	CURRENT NEED	SHORT TERM NEED	INTERMEDIATE NEED	LONG TERM NEED
Aircraft Positions					
Shade Hangars	51	48	56	63	71
T-Hangars	47	44	60	76	114
Conventional Hangars	81	70	85	97	118

APRON TIE DOWNS




	AVAILABLE	CURRENT NEED	SHORT TERM NEED	INTERMEDIATE NEED	LONG TERM NEED
Local Tiedowns*	80	70	64	56	50
Transient Ramp Positions	151	118	127	130	147

GENERAL AVIATION TERMINAL SERVICES



	AVAILABLE	CURRENT NEED	SHORT TERM NEED	INTERMEDIATE NEED	LONG TERM NEED
Terminal/Administration (s.f.)	1,650	3,000	3,800	4,700	6,300
Maintenance Hangar (s.f.)	44,000	41,000	46,000	51,000	62,000
Fuel Storage (gal.)					
Avgas	24,000	11,200	14,400	16,400	20,600
JetA	0	1,000	2,800	5,600	9,000

AUTO PARKING



	AVAILABLE	CURRENT NEED	SHORT TERM NEED	INTERMEDIATE NEED	LONG TERM NEED
Parking Spaces	236	72	92	112	151

*Nonstate are considered for tiedowns.

